Respiratory Medicine (2010) **104**, 749–753

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/rmed

SHORT SURVEY

Tracheostomy in patients with long-term mechanical ventilation: A survey

Santino Marchese [a,*], Antonio Corrado [b], Raffaele Scala [c], Salvatore Corrao [d], Nicolino Ambrosino [e,f], On behalf of the Intensive Care Study Group, Italian Association of Hospital Pulmonologists (AIPO)

[a] *Respiratory Intensive Care Unit, Terapia Intensiva Respiratoria, Ospedale Civico, ARNAS, Via C. Lazzaro, 2 — 90129 Palermo, Italy*
[b] *Respiratory Intensive Care Unit, Azienda Ospedaliera-Universitaria Careggi, Firenze, Italy*
[c] *Pulmonary Unit, Ospedale S. Donato, ASL 8 Arezzo, Italy*
[d] *Department of Medicine, University of Palermo, Italy*
[e] *Cardiothoracic Department, Pulmonary Unit, University Hospital of Pisa,Volterra, Italy*
[f] *Weaning and Pulmonary Rehabilitation Unit, Auxilium Vitae, Volterra, Italy*

Received 10 July 2009; accepted 5 January 2010
Available online 1 February 2010

KEYWORDS
Tracheostomy;
Intensive care unit;
Long-term mechanical ventilation;
Respiratory failure

Summary
Background: Tracheostomy is increasingly performed in intensive care units (ICU), with many patients transferred to respiratory ICU (RICU). Indications/timing for closing tracheostomy are discussed.
Aim and Method: We report results of a one-year survey evaluating: 1) clinical characteristics, types of tracheostomy, complications in patients admitted to Italian RICU in 2006; 2) clinical criteria and systems for performing decannulation, and outcome of patients undergoing tracheostomy (number decannulated; number non-decannulated/non-ventilated; number non-decannulated/ventilated; dead/lost patients).
Results: 22/32 RICUs replied. There were 846 admissions of 719 patients (Mean age 64,3 (±14.2) years, 489 (68%) males). Causes of admission were: acute respiratory failure with underlying chronic co-morbidities 176 (24.4%); exacerbation of Chronic Obstructive Pulmonary Disease 222 (34.4%); neuromuscular diseases 200 (27.8%); surgical patients 77 (10.7%); thoracic dysmorphism 28 (3.8%); obstructive sleep apnea syndrome 16 (2.2%). Percutaneous tracheostomies were 65.9%. Major complications after tracheostomy were 2%. 427 tracheostomies were evaluated for decannulation: 96 (22.5%) were closed; 175 patients (41%) were discharged with home mechanical ventilation; 114 patients (26.5%) maintained the tracheostomy despite weaning from mechanical ventilation and 42 patients (10%) died or lost.

* Corresponding author. Tel.: +39 091 666 3506; fax: +39 091 666 3505.
E-mail address: smarchese1@tiscali.it (S. Marchese).

0954-6111/$ - see front matter Published by Elsevier Ltd.
doi:10.1016/j.rmed.2010.01.003

The clinical criteria chosen for decannulation were: stability of respiratory conditions, effective cough, underlying diseases and ability to swallow. The systems for evaluating feasibility of decannulation were: closure of tracheostomy tube; laryngo-tracheoscopy; use of tracheal button and down-sizing.
Conclusions: There were few major complications of tracheostomy. A substantial proportion of patients maintain the tracheostomy despite not requiring mechanical ventilation. There was no agreement on indications and systems for closing tracheostomy.
Published by Elsevier Ltd.

Tracheostomised patients represent about 10% of all patients receiving mechanical ventilation (MV),[1,2] the prevalence is growing for several reasons: 1) availability of simpler bedside procedures. Percutaneous dilational tracheostomy (PDT) offers several potential advantages compared with surgical tracheostomy, and is increasingly used;[1–5] 2): a need for less sedation when compared with translaryngeal intubation;[6] 3); a more rapid and simpler weaning process;[7] 4); reduced length of stay in intensive care unit (ICU) and relative lower costs.[7] The increased prevalence of tracheostomy is associated with earlier admissions to respiratory intensive care units (RICU), but the indications and timing of decannulation are still being discussed.[8,9]

This paper reports the results of a detailed survey evaluating: 1) clinical characteristics, types of tracheostomy and complications of patients admitted to Italian RICU in 2006; 2) clinical criteria and systems for performing decannulation, and outcome of patients who have undergone tracheostomy.

Methods

For the purposes of this retrospective cross-sectional survey, we only considered tracheomies performed due to the need for MV for longer than 15 days,[10,11] excluding patients who had undergone tracheostomy for upper airway obstruction or ineffective cough.

Centre individuation

The definition and characteristics of RICU were in line with the European Respiratory Society task force.[12] In RICUs patients are treated for: acute and acute on chronic respiratory failure by non-invasive and invasive mechanical ventilation, difficult weaning, long-term mechanical ventilation for longer than 15 days[11] and exacerbation of respiratory failure in patients ventilated invasively at home. We used the database from the Italian Respiratory Society (AIPO: Associazione Italiana Pneumologi Ospedalieri) indicating 26 RICUs, described elsewhere,[13] plus those from 6 other centres.

Survey content

The period analysed was 2006, and the patients recruited are reported in flowchart (Fig. 1). A covering letter and 2 questionnaires were sent by e-mail, in April 2007, to all centres. One questionnaire evaluated the prevalence of admitted tracheostomised patients, and diseases leading to tracheostomy (13 items); the other dealt with the main criteria and modalities of decannulation (9 and 4 items respectively). The written material was e-mailed to all centres not returning the survey three times, and in this event a telephone reminder-call was made. The deadline for receipt of the completed survey was 30 October 2007. Questionnaire items are shown in Appendix.

The physicians in charge of RICU answered the questions.

Data entry and analysis

For each item the total sum was recorded. Responders had to score 0–5 (0 = not important and 5 = very important) for each of 13 items dealing with criteria and modalities of decannulation and the total scores from all the centres were added up. As 22 centres answered the questionnaires the theoretical maximum score for a single item was 110 (22 centres × 5).

Statistical analysis

The Freeman–Turkey variant of the arcsine square root transformed proportions was used to compute random effect summaries. Pooled proportions were calculated as the back-transformation of the weighted mean of the transformed proportions, using DerSimonian–Laird weight. Proportions are shown as pooled values (95% Confidence Interval lower-upper values).

Cronbach's coefficient alpha was performed for scale reliability.

Results

Twenty-two out of 32 centres completed and returned the survey. The number of tracheostomised patients admitted to RICU in 2006 was 846 (single centre median = 24.5) for a total 719 patients (median = 20) (Mean ± Standard Deviation age: 64,3 ± 14.2 years, 489 (68%) males). Four hundred and eleven (61,6%) patients were aged over 70 years. The number of tracheostomised patients and their lot is reported in Fig. 1. 95% of patients maintaining tracheostomy despite weaning from MV had co-morbidities or were aged over 70 years or both.

Patients admitted with acute respiratory failure due to different chronic diseases (nephrologic, neurologic, cardiologic etc.), COPD and neuromuscular, amounted to 176 (24.4%), 222 (30.9%), 200 (27.8%) respectively. Surgical patients were 77 (10.7%), while thoracic dysmorfism and OSAS were 28 (3.9%) and 16 (2.2%). Only 15/719 (2%) of patients suffered from major complications (fistula or stenosis) after tracheostomy.

The scores of the main clinical criteria and the tests used to indicate decannulation and tracheostomy closure

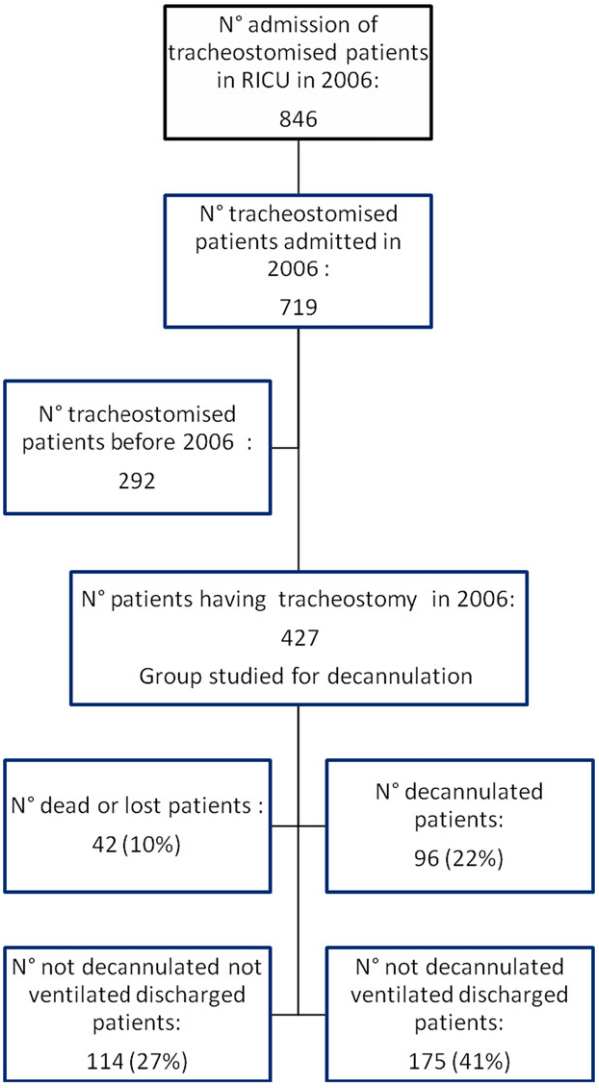

Figure 1 Flowchart tracheostomised patients admitted in 22 Italian RICU in 2006. Lost = patients who were transferred to other units or patients who refuted to close tracheostomy.

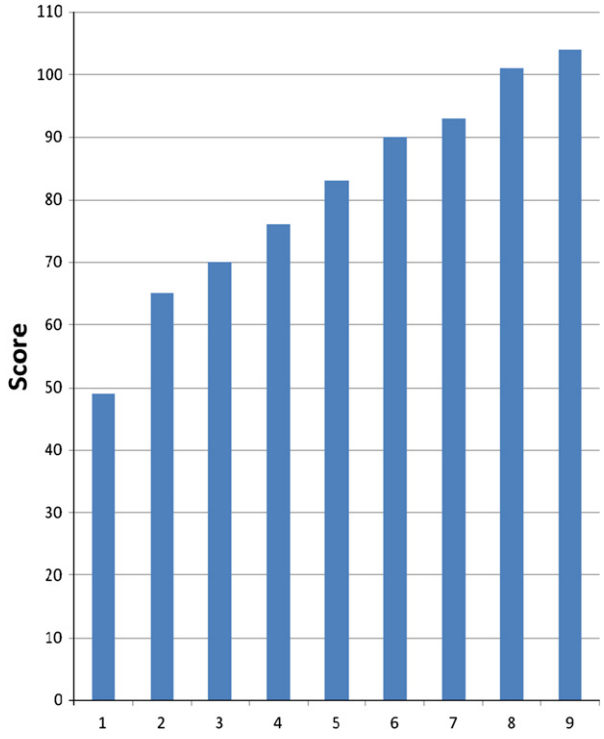

Figure 2 Criteria for closure tracheostomy: clinical parameters. Calculus score: each parameter had a score of 0—5 and a each centre was only permitted to provide one score. Total score was given from sum of single score. E.g. If all centers gave max score, total score was 110/110 (22 centers × 5 = 110). 1 = difficult intubation. 2 = 1 + history of chronic respiratory failure. 3 = need of home mechanical ventilation in stable state. 4 = 3 + hours/day ventilation. 5 = $PaCO_2$ level in stable state. 6 = swallowing disturbance. 7 = underlying disease. 8 = cough effectiveness. 9 = number of relapses of diseases in the last year. (see Appendix)

are reported in Figs. 2 and 3. There were only 5 parameters with score >80, and specifically: arterial carbon dioxide tension ($PaCO_2$) in stable state; no swallowing problems; kind and severity of disease; presence of effective cough; stability of respiratory parameters (Dyspnoea; Respiratory rate; SaO_2; arterial oxygen tension (PaO_2); $PaCO_2$; pH). Among the tests only the tracheostomy tube occluded with a cap scored more than 80.

Cronbach's coefficient alpha was 0.64, which was considered consistent for the internal reliability of our survey questionnaire.

Discussion

This survey highlights some interesting points about tracheostomised patients. There was a high prevalence of tracheostomised patients admitted to RICU, especially patients with several underlying chronic co-morbidities without any history of respiratory diseases. The presence of this significant group of patients with co-morbidities in RICU represents fresh data, if compared with the results of a previous Italian study.[13] The recent introduction of simpler and less invasive bedside methods, such as percutaneous tracheostomy[1–5] is associated with an increased number of tracheostomised patients. In our survey, percutaneous tracheostomies were performed more frequently than surgical ones (65.9% vs 34.1%). Patients with major complications were few (2%), regardless of the method of tracheostomy (i.e. either percutaneous or surgical). Briggs[14] reports, in cardiac surgical patients, 11% bleeding at the time of insertion (intraoperative or perioperative complication), but this is probably an high-risk group of patients. We can't analyze this type of complication because some tracheostomies were performed in ICU.

The most frequent indication for tracheostomy is the need for prolonged MV in the ICU,[11] In this way the time spent in ICU can be reduced for those patients, because tracheostomy allows them to be transferred to other step-down units.[7] Recently Boles[15] published a new classification of patients according to the weaning process, but the timing of tracheostomy was not defined. Cox et al[16] reported that 25% of tracheostomised patients died in hospital; 23% were discharged to rehabilitation or long-

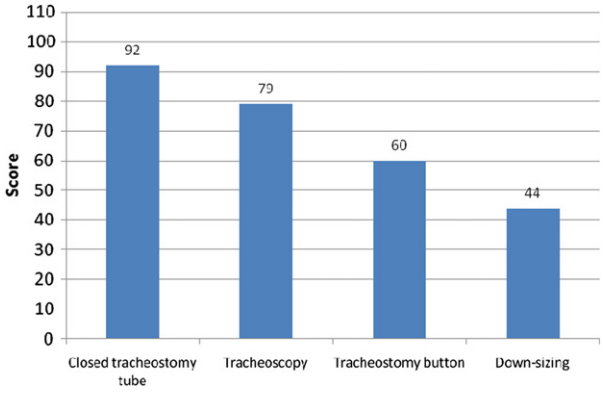

Figure 3 Closure of tracheostomy: scores of the tests for evaluation of airways. Calculus scoreeach parameter had a score of 0—5 and a each centre was only permitted to provide one score. Total score was given from sum of single score. E. g.: If all centers gave max score, total score was 110/110 (22 centers × 5 = 110).Closed tracheostomy tube = occluded with a cap. Down-sizing = use of decreasing size of tracheostomy tubes.

term care units; only 8% were discharged home. The conclusion was that tracheostomy increased the proportion of dependent survivors bearing the heavy burden of chronic disease. The results of our study suggest the need for considerable care for these patients. All this might increase the cost of care outside the ICU.

Another interesting result of this survey is that tracheostomy was maintained in a substantial proportion of patients without any need for prolonged MV; in this group 95% of patients had co-morbidities or were aged over 70 years or both. These results are in agreement with those of Engoren et al.,[17] but very different from those of Tobin et al.[18] Indeed 40% of patients in that single centre study[18] were cardiac surgical. We think that the size of this group of not-decannulated patients was due to their serious disease or age, and therefore it is not easy to take a decision about tracheostomy closure.

When we evaluated indications for closing tracheostomy, the five criteria most often cited by interviewed centres were: stability of respiratory conditions, effective cough, slowly progressive underlying disease, effective swallowing and no or mild hypercapnia in stable patients. The other criteria were scored differently among centres and this can be explained by the fact that there are no exact guidelines for closing tracheostomy. Heffner[19] proposed the following checklist to determine whether the patient might be decannulated: 1) Is MV no longer required? 2) Are airway secretions controlled? 3) Is aspiration non-existent or minimal and well tolerated? 4) Does the patient have an effective cough? An important point is the absence in Heffner's checklist of judgement about severity of disease ($PaCO_2$, prognosis and stability). Studies are needed to evaluate accepted criteria for safely closing tracheostomy. We think that there are two possibilities for studying this problem: 1) exploratory study in a cohort of tracheostomised patients to measure parameters in use for decannulation; 2) To use the information from our study and others to decide in a consensus conference which parameters are more valid, and to compare a free approach with a consensus structured approach. Outcomes might be: 1) prevalence of decannulation; 2) length of hospital stay; 3) short and a long-term survival; 3) prevalence of hospital readmissions.

Finally we looked for the most widely-accepted tests for evaluating airways before decannulation In agreement with Veelo et al.[20] we might conclude that tracheostomy-management guidelines are lacking and much-needed.

Limitations

The response rate, in our survey, was 68,75%, an adequately representative sample of Italian RICU. Even though the test for internal reliability was consistent, the results of our survey, in our opinion, are not comparable with other European ICU, because the type of patients admitted and the physician in charge (internist, surgical…) are very different.[14—20]

Conclusions

This survey confirms that today there are many areas that are not clearly defined with regard to tracheostomised patients. Clinical parameters and systems for evaluating airways are not clearly defined. Many patients discharged without MV are not decannulated. We do not know the costs incurred for this patient outside the hospital. We need studies to validate simple, rapid systems for indicating decannulation, but also studies regarding the survival-rate of this group of patients and costs.

Acknowledgements

The authors would like to thank A. Ozols for linguistic revision of the manuscript.Participating centres and investigators. Mantova 01 (V. Galavotti); Perugia (S.Baglioni); Pavullo(Mo) (E.Clini); Trieste (M.Confalonieri); Milano (G. Gallimbeni); Rho (S. Benorio); Firenze (M.Gorini); L'Aquila (P.Carducci); Sestri Levante (A.Nicolini); Lecce (S.Scoditti); Padova (A. Vianello); Mantova 02 (C. Scarduelli); Pavia (P.Ceriana); Forlì (F.Fiorentini); Alessandria (E.Mantellini); Cittadella (G.Idotta); Gussago (M.Vitacca); Germaneto (F.Roccia); Tradate (A.Lucioni); Udine (A. Peratoner).

Appendix 1. Questionnaire items

Period: January—December 2006.

- Age of patients (Mean ± Standard Deviation)
- Number of males
- Number of tracheostomies admitted.
- Number of tracheostomised patients.
- Number of tracheostomies performed.
- Number of new tracheostomies admitted in 2006.
- Number of surgical/percutaneous tracheostomies.
- Number of tracheostomised patients in home mechanical ventilation.

- Number of patients not closing tracheostomy.
- Number of patients with tracheostomy, deceased or lost patients (patients transferred to other units, patients refusing to close tracheostomy).
- Distribution of diseases among tracheostomised patients:

  Surgical; Medical multi-pathologies; COPD; Neuromuscular; Kyfoscoliosis; OSAS.
- Number of patients having major complications (fistula or stenosis) after tracheostomy.
- Number of patients $>$ 70 y old.

Valuated criteria to close tracheostomy: score 0—5.

- Patient's disease (slow evolution of disease).
- Stability Respiratory failure (dyspnea; respiratory rate; SaO_2; PaO_2; $PaCO_2$; pH).
- Gas-analysis in stable patients (elevated values of $PaCO_2$ in stable conditions).
- Efficacy of cough.
- No disturbed swallowing.
- Difficult intubation (difficulty seeing the airway, or the oral tube does not proceed because of abnormal condition of trachea).
- Difficult intubation (see before) only in presence of chronic respiratory failure.
- Use of ventilation after stability.
- Hours/day of ventilation after stability.
- Closed tracheostomy tube (occluded with a cap).
- Tracheoscopy.
- Tracheostomy button.
- Down-sizing (use of decreasing size of tracheostomy tubes).

Conflict of interest

Authors have reported no conflict of interest.

References

1. Kollef MH, Ahrens TS, Shannon W. Clinical predictors and outcomes for patients requiring tracheostomy in the intensive care unit. *Crit Care Med* 1999;**27**:1714—20.
2. Fischler L, Erhart S, Kleger GR, Frutiger A. Prevalence of tracheostomy in ICU patients: a nation-wide survey in Switzerland. *Intensive Care Med* 2000;**26**:1428—33.
3. Hazard P, Jones C, Benitone J. Comparative clinical trial of standard operative tracheostomy with percutaneous tracheostomy. *Crit Care Med* 1991;**19**:1018—24.
4. Friedman Y, Fildes J, Mizock B, Samuel J, Patel S, Appavu S, et al. Comparison of percutaneous and surgical tracheostomies. *Chest* 1996;**110**:480—5.
5. Freeman BD, Karen I, Lin N, Buchman TG. A meta-analysis of prospective trials comparing percutaneous and surgical tracheostomy in critically III patients. *Chest* 2000;**118**:1412—8.
6. Heffner JE. Medical indications for tracheostomy. *Chest* 1989; **96**:186—90.
7. Brook AD, Sherman G, Malen J, Kolleff MH. Early versus late tracheostomy in patient who require prolonged mechanical ventilation. *Am J Crit Care* 2000;**9**:352—9.
8. Kent LC. Tracheostomy decannulation. *Respir Care* 2005;**50**: 538—41.
9. Ceriana P, Carlucci A, Navalesi P, Rampulla C, Delmastro M, Piaggi G, et al. Weaning from tracheostomy in long-term mechanically ventilated patients: feasibility of a decisional flowchart and clinical outcome. *Intensive Care Med* 2003; **29**(5):845—8.
10. Rumbak MJ, Newton M, Truncale T, Adams JW, Hazard PB. A prospective, randomized, study comparing early percutaneous dilational tracheostomy to prolonged translaryngeal intubation (delayed tracheotomy) in critically ill medical patients. *Crit Care Med* 2004;**32**:1689—94.
11. A collective task force facilitated by the American college of chest physicians, the American association for respiratory care and the American college of critical care medicine. Evidence-based guidelines for weaning and discontinuing ventilatory support. *Chest* 2001;**120**:375S—395S.
12. European respiratory task force on epidemiology of respiratory intermediate care in Europe. Respiratory intermediate care units: a European survey. *Eur Respir J* 2002;**20**: 1343—50.
13. Confalonieri M, Gorini M, Ambrosino N, Mollica C, Corrado A. Scientific group on respiratory intensive care of the Italian association of hospital pneumonologists. Respiratory intensive care units in Italy: a national census and prospective cohort study. *Thorax* 2001;**56**:373—8.
14. Briggs S, Ambler J, Smith D. A survey of tracheostomy practice in a cardiothoracic intensive care unit. *J Cardiothorac Vasc Anesth* 2007;**21**(1):76—80.
15. Boles JM, Bion J, Connors A, Herridge M, Marsh B, Melot C, et al. Weaning from mechanical ventilation. *Eur Respir J* 2007; **29**:1033—56.
16. Cox CE, Carson SS, Holmes GM, Howard A, Carey TS. Increase in tracheostomy for prolonged mechanical ventilation in North Carolina, 1993—2002. *Crit Care Med* 2004;**32**: 2219—26.
17. Engoren M, Arslanian-Engoren C, Fenn-Buderer N. Hospital and long-term outcome after tracheostomy for respiratory failure. *Chest* 2004;**125**:220—7.
18. Tobin AE, Santamaria JD. An intensivist-led tracheostomy review team is associated with shorter decannulation time and length of stay: prospective color study. *Crit Care* 2008; **12**:R48.
19. Heffner JE. The technique of weaning from tracheostomy: criteria for weaning; practical measures to prevent failure. *J Crit Illn* 1995;**10**(10):729—33.
20. Veelo DP, Schultz MJ, Phoa KY, Dongelmans DA, Binnekade JM, Spronk PE. Management of tracheostomy: a survey of Dutch intensive care units. *Respir Care* 2008; **53**(12):1709—15.